CETN I-48
(12/91)

Coastal Engineering Technical Note

Evaluation and Application
of the
Wave Information Study for the Gulf of Mexico

INTRODUCTION

The Wave Information Study (WIS) for the Gulf of Mexico (WIS Report 18) provides a wave climate for the U.S. shorelines of the Gulf of Mexico based on simulation of 20 years of weather data from the period 1956-1975. During these years few wave data exist with which to evaluate the adequacy of the total hindcast procedure which includes derivation of pressure charts, translation of these into wind estimates, and then calculation of wave conditions. In 1991 CERC conducted a one-year hindcast of the Gulf of Mexico for the year 1988 and evaluated the model results against extensive wind and wave measurements now available in order to provide guidance on the quality of the previous hindcast work. The results of that study are reported in WIS Report 28 (Hubertz and Brooks, in publication). This CETN provides a brief summary of that hindcast and guidance on the use of the earlier WIS study.

1988 HINDCAST STUDY

Since almost no wave data exist in the Gulf of Mexico for the 1956-1975 period, CERC decided to hindcast a recent year, 1988, in which extensive wave and wind data were available using data and procedures as close to those used for the 1956-1975 hindcast as possible. Wind data for the Gulf of Mexico were obtained from the Fleet Numerical Oceanographic Center (FNOC) and interpolated onto the Gulf of Mexico grid used in the original study. These winds were used to drive SHALWV, the original wave model used for the 1956-1975 study, and the wave conditions were estimated and compared to six offshore National Data Buoy Center wave buoys and one coastal gage.

The differences between the 1988 and 1956-1975 study are in the use of FNOC winds rather than those derived by the WIS wind model used for 1956-1975 and in the inherent difference between the year 1988 and the period 1956-1975. WIS experience is that the FNOC- and WIS-produced winds are not strongly different and that 1988 was not an atypical year. Hence, the differences seen between the measured and modelled results are likely to be typical of the differences between the statistics hindcast for 1956-1975 and what would have been measured.

RESULTS

The six buoys and one shallow water gage are located as shown in Figure 1. Three of the buoys (42001-42003) are located in deep water across the center of the Gulf of Mexico; the other sites are very close to land off Mississippi and Alabama and off Clearwater, FL. Of the six buoys, the three in the center

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
DEC 1991		**00-00-1991 to 00-00-1991**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Evaluation And Application Of The Wave Information Study For The Gulf Of Mexico	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **US Army Engineer Waterways Experiment Station,Coastal Engineering Research Center,3909 Halls Ferry Road,Vicksburg,MS,391804**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The Wave Information Study (WIS) for the Gulf of Mexico (WIS Report 18) provides a wave climate for the U.S. shorelines of the Gulf of Mexico based on simulation of 20 years of weather data from the period 1956-1975. During these years few wave data exist with which to evaluate the adequacy of the total hindcast procedure which includes derivation of pressure charts translation of these into wind estimates, and then calculation of wave conditions. In 1991 CERC conducted a one-year hindcast of the Gulf of Mexico for the year 1988 and evaluated the model results against extensive wind and wave measurements now available in order to provide guidance on the quality of the previous hindcast work. The results of that study are reported in WIS Report 28 (Hubertz and Brooks, in publication). This CETN provides a brief summary of that hindcast and guidance on the use of the earlier WIS study.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**7**	

of the Gulf are probably more representative of the general quality of the hindcasts. The ones very close to shore can be affected by grid discritization problems. The bias and RMS errors in wind speed are given in Table 1, and similar values for the wave height and peak period are given in Tables 2 and 3 respectively.

Table 1 indicates that the magnitude of the bias between the predicted and measured wind speeds ranges on a monthly basis from 0.3 to -3.9 knots with the overall bias typically about 2.5 knots with the model under predicting the winds. The RMS error in wind speeds ranges from 2.1 to 4.9 knots on a monthly basis with a typical value of 3.5 knots.

Table 2 indicates that the wave height predictions have a bias of 0.0 to -0.6 m relative to the measurements with the predictions biased low on a monthly basis. Overall, the bias is about 0.1 m low. The RMS error in wave height on a monthly basis ranged from 0.1 to 1.0 m with a typical value of about 0.25 m. Table 3 indicates that the wave peak periods predicted tended to be biased low by from 0.0 to -2.8 set on a monthly basis, with the overall bias about 1 set low. The RMS error in wave period ranged monthly from 0.9 to 4.1 set with the typical value about 2 sec.

Analysis of individual events indicates that the 1988 hindcasts do not necessarily handle tropical events well because these events are not modeled well by FNOC global analyses. This is because of the large size of the grid mesh and is also true of the original hindcasts. WIS addressed this by an individual set of hurricane hindcasts to accompany the synoptic events study (WIS Report 19, Abel, et. al., 1989). Analysis also indicates that the 1988 hindcasts missed several individual events by 1 to 2 m in significant height. These events were rapidly shifting and veering wind events associated with "northers." In these situations the winds which could be documented were usually under predicted. The lack of resolution of northers in the Gulf also may be present in the 1956-1975 hindcasts. However, these events usually produce waves propagating away from U.S. shorelines since the wind is blowing from north to south, and thus will be unimportant for shallow water wave climates. For continental shelf work, a correction may be considered.

The errors in wind and waves reported are very small compared to values obtained for Atlantic or Pacific comparisons. However, users must also recognize that the waves are correspondingly smaller on average in the Gulf.

RECOMMENDATIONS

Based on the 1988 hindcast, users of the WIS Gulf data set for the period 1956-1975 should interpret the data to have the following range of accuracies:

a. Wind speed: low in the mean by 2.5 knots, RMS error 3.5 knots.

b. Significant wave height: low in the mean by 0.1 m, RMS error 0.25 m.

c. Peak period: low in the mean by 1 set, RMS error 2 sec.

Significant wave heights, in deep water away from the coast, due to "norther" events may be too low by l-2 m. If a project involves wave conditions away from the coast due to norther events, the user may contact Ms. Barbara A. Tracy at (601) 634-2400, Barbara.A.Tracy@erdc.usace.army.mil for assistance in determining design conditions. Wave information for hurricane and tropical storm conditions should be obtained from WIS Report 19

REFERENCES

Abel, C. E., Tracy, B. A., Vincent, C. L., Jensen, R. E. 1989. "Hurricane Hindcast Methodology and Wave Statistics for Atlantic and Gulf Hurricanes from 1956-1975," WIS Report 19, US Waterways Experiment Station, Vicksburg, MS.

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Table 1
Summary Statistics for FNOC Winds in 1988

Bias (kts) of FNOC Wind Speeds to Measured at Buoys by Month

Buoy	J	F	M	A	M	J	J	A	S	O	N	D
42001	0.3		-1.0	-1.4	-2.7					-1.5	-2.3	-0.5
42002	-3.3	-2.2	-3.3	-2.2	-3.1		-1.4	-1.5	-2.1	-2.6	-3.9	-3.8
42003							-1.8	-1.9	-1.7	-2.3	-3.6	-3.4
42007			-3.1	-3.6	-3.0		-3.6	-3.8	-2.7	-3.5	-3.2	-2.8
42015	-2.2	-1.5	-2.2	-2.6	-1.9		-2.7	-3.3				-0.9
42016					-2.0		-2.9	-3.2	-1.7	-2.8	-2.3	-2.0

Bias = Calculated Monthly Average - Measured Monthly Average

Root Mean Square Difference (kts) of FNOC Wind Speeds from Buoy

Buoy	J	F	M	A	M	J	J	A	S	O	N	D
42001	4.3		3.7	2.9	3.9					3.2	4.1	4.0
42002	3.7	4.0	3.6	4.0	2.8		3.2	3.0	3.8	2.8	4.0	3.4
42003							2.4	2.8	3.4	2.7	4.9	3.7
42007			3.4	3.3	3.1		2.9	4.8	4.8	3.0	3.8	3.1
42015	2.8	3.7	3.3	3.1	2.6		2.1	3.8				2.9
42016					2.6		2.0	3.0	4.1	2.4	3.2	3.1

Number of Cases Compared

Buoy	J	F	M	A	M	J	J	A	S	O	N	D
42001	119		160	240	246					148	240	246
42002	247	230	248	237	214		245	246	238	245	239	245
42003							246	247	239	248	237	247
42007			248	235	246		241	187	238	242	239	247
42015	246	230	245	237	242		244	242				135
42016					246		247	246	239	244	239	112

Table 2
Summary Statistics for Model Wave Heights for 1988

Bias (m) of Wave Height from Measurements

Buoy	J	F	M	A	M	J	J	A	S	O	N	D
42001	-0.3		-0.2	-0.1	-0.2					-0.2	-0.4	-0.2
42002	-0.5	-0.2	-0.2	-0.2	-0.3		-0.1	-0.1	-0.1	-0.4	-0.3	-0.4
42003							-0.2	-0.3	-0.2	-0.3	-0.6	-0.4
42007	0.0	0.1			0.1		0.0	-0.1	0.2	0.0	0.1	0.0
42015	0.0	0.1	0.0	0.0	-0.1		-0.1	-0.2				-0.2
42016					0.0		0.0	0.0	0.3	0.0	0.1	0.1
U FL	0.2	0.4	0.2	0.2	0.1		0.0	0.0	0.4	0.1	0.3	0.1

Bias = Calculated monthly average minus measured monthly average

Root Mean Square Difference (m) of Wave Height

Buoy	J	F	M	A	M	J	J	A	S	O	N	D
42001	0.5		0.4	0.4	0.4					0.3	0.5	0.3
42002	0.5	0.5	0.5	0.4	0.2		0.2	0.2	0.8	0.4	0.4	0.3
42003							0.2	0.2	0.5	0.3	0.8	0.4
42007	0.3	0.3			0.2		0.2	0.3	0.4	0.2	0.3	0.2
42015	0.4	0.3	0.3	0.3	0.2		0.2	0.3				0.4
42016					0.2		0.1	0.2	0.4	0.3	0.3	0.3
U FL	0.3	0.3	0.4	0.4	1.0		0.1	0.2	0.4	0.3	0.8	0.3

Number of Cases

Buoy	J	F	M	A	M	J	J	A	S	O	N	D
42001	106		159	240	246					246	239	245
42002	247	231	248	239	144		246	246	237	246	238	247
42003							245	242	238	248	236	244
42007	237	215			245		246	144	237	238	224	228
42015	247	230	247	233	246		245	234				132
42016					246		247	245	238	234	228	105
CDN	102	31	72	86	15		40	108	82	60	10	111

Table 3
Summary Statistics for Model Periods for 1988

Bias (s) of Wave Peak Period from Measurements

Buoy	J	F	M	A	M	J	J	A	S	O	N	D
42001	-0.7		-0.5	-0.7	-0.9					-1.1	-0.7	-1.0
42002	-0.9	-0.6	-0.3	-0.7	-0.9		-1.4	-1.5	-0.3	-1.3	-0.5	-0.9
42003							-2.3	-2.8	-0.3	-1.6	-1.4	-1.3
42007	-0.2	0.3	-0.6		-0.1		-0.8	-0.9	0.2	-0.6	0.1	-0.5
42015	-0.4	-0.1	-0.9	-0.6	-1.0		-1.1	-1.5				-1.4
42016					-1.1		-1.0	-1.4	-0.3	-0.4	-0.3	-0.4
U FL	0.0	0.2	-0.6	-0.7	-1.1		0.2	-1.1	-0.3	0.5	0.7	-0.6

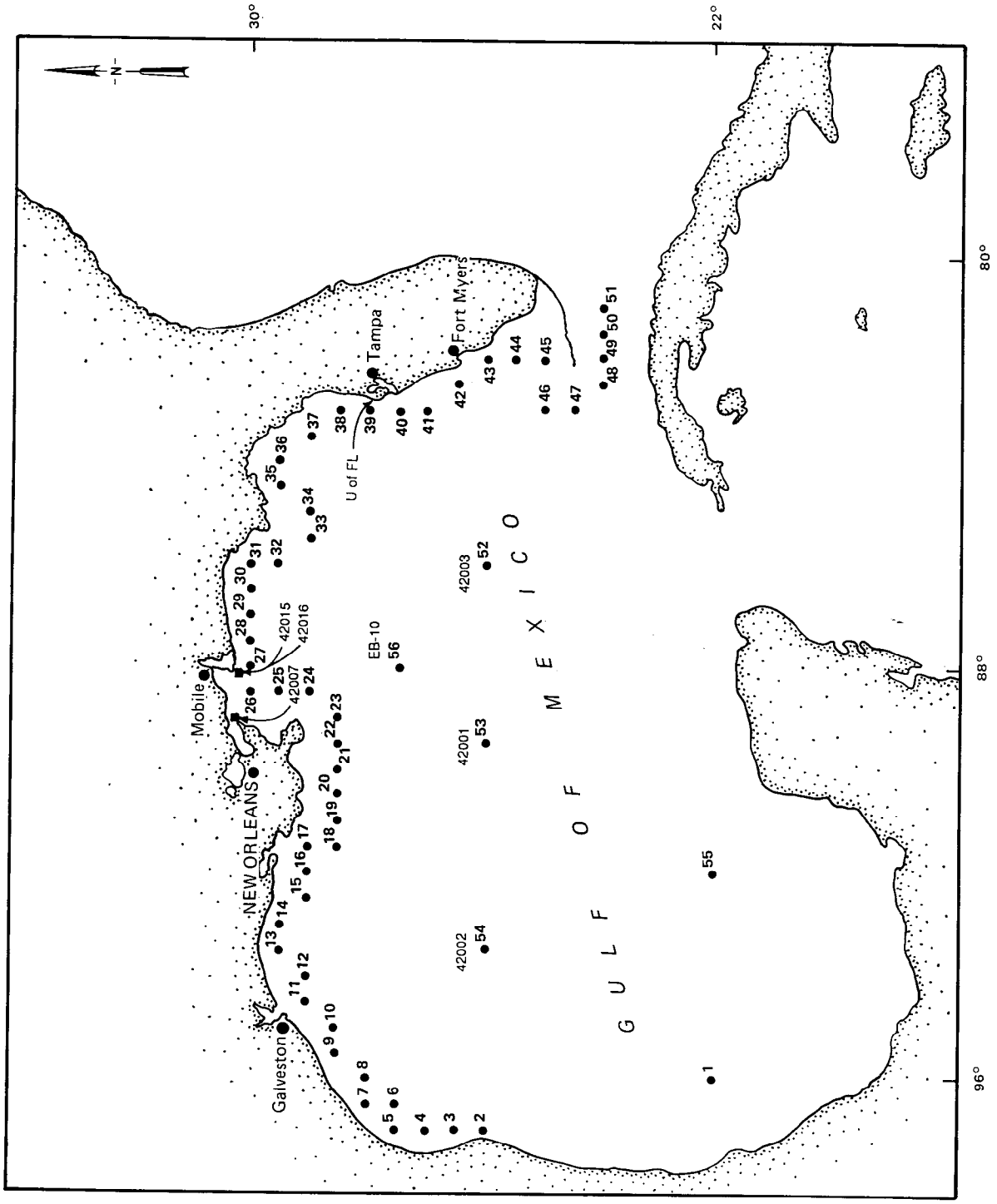
Bias = Calculated monthly average minus measured monthly average

Root Mean Square Difference (s) of Peak Period

Buoy	J	F	M	A	M	J	J	A	S	O	N	D
42001	1.7		0.9	1.4	1.9					1.3	1.4	1.1
42002	1.5	1.3	1.4	0.9	1.1		2.1	1.5	1.5	1.4	1.3	1.6
42003							2.3	1.9	2.2	1.5	1.2	1.1
42007	2.3	2.2	1.8		2.4		2.1	1.6	2.0	2.0	1.8	1.9
42015	2.3	2.1	2.2	2.0	2.5		1.7	1.6				1.7
42016					2.6		1.7	1.8	1.9	2.0	2.1	2.3
U FL	2.1	1.6	2.0	2.0	3.5		1.9	1.7	4.1	2.5	2.2	2.0

Number of Cases

Buoy	J	F	M	A	M	J	J	A	S	O	N	D
42001	106		159	240	246					246	239	245
42002	247	231	248	239	144		246	246	237	246	238	247
42003							245	242	238	248	236	244
42007	237	215			245		246	144	237	238	224	228
42015	247	230	247	233	246		245	234				132
42016					246		247	245	238	234	228	105
CDN	102	31	72	86	15		40	108	82	60	10	111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